THE KAURI STUDIES TRUST– A SCOPING REPORT ON THE POTENTIAL FOR RESEARCH AT THREE STREAMS AND KAURI GROVE RESERVES

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Commissioned by The Kauri Studies Trust

i. EXECUTIVE SUMMARY

The Kauri Studies Trust (The Trust) endeavours to support kauri-related research, with a particular focus on kauri in urban and peri-urban areas. This report was commissioned by the Trust in order to understand how it can best support future research, and to investigate the suitability of Three Streams (TS) and Kauri Grove (KG) reserves as study sites. The contents are the culmination of three full days of field investigation, reviews existing literature, and discussions with representatives from Auckland City, the Department of Conservation, and the Kauri Studies Trust.

A synthesis of previous studies at TS, KG, and the surrounding areas is provided. This informs a discussion about the suitability of TS and KG as study sites for future research supported by The Kauri Studies Trust. The report finds that TS and KG benefit from their proximity to major research institutions, existing geospatial and reference data, and proximity to other reserves with similar vegetation cover. A barrier to future research at TS and KG is that both assets are owned and managed by Auckland City (with TS being subject to an Open Space Covenant pursuant to the Queen Elizabeth the Second National Trust Act 1977). Therefore, any future research at these sites requires their approval; non-invasive research is likely to be favoured in the approval process. While the ownership status of TS and KG may limit particular types of future research, there is great potential for broad-scale studies of kauri response to environmental factors, climate, and urban encroachment. These types of research can take advantage of the human capital within the Auckland region, as well as the wealth of available ecological and geospatial data.

The report concludes by recommending that the Kauri Studies Trust: (i) obtain permission for future research at TS and KG reserves; (ii) establish a clear set of research themes; (iii) ensure that the provision of high-quality baseline data remain available and accessible to potential researchers; and (iv) actively engage with the research community.

This report is accompanied by a digital archive of all previous works, map data (in ArcGIS formats), and a list of key research and Auckland City contacts. This archive helps to ensure that all known data pertaining to the study area, in particular unpublished works, are documented and digitised.

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1. Introduction

The Kauri Studies Trust (also referred to herein as the Trust) endeavours to support kauri-related research. The scope for research is broad, though kauri (*Agathis australis*) in the urban and peri-urban landscape have been highlighted by the Trust as being of particular interest. Future research is not limited to Three Streams (TS) and Kauri Grove* (KG) reserves, but these sites have been the subject of numerous former studies and, therefore, are the focus of this report.

2. Data Collection and Methods

The contents and recommendations made in this report were informed by three full days of field investigation, thorough revision of existing literature, and discussions with representatives from Auckland City, the Department of Conservation, and the Kauri Studies Trust. All maps were produced by the author in ArcGIS with data sourced by the author (during the site visit), from Auckland City, from Land Information New Zealand, from Landcare Research, or by digitising paper maps produced in previous reports. All maps and data are included with this report as a digital archive and have been provided to the Kauri Studies Trust.

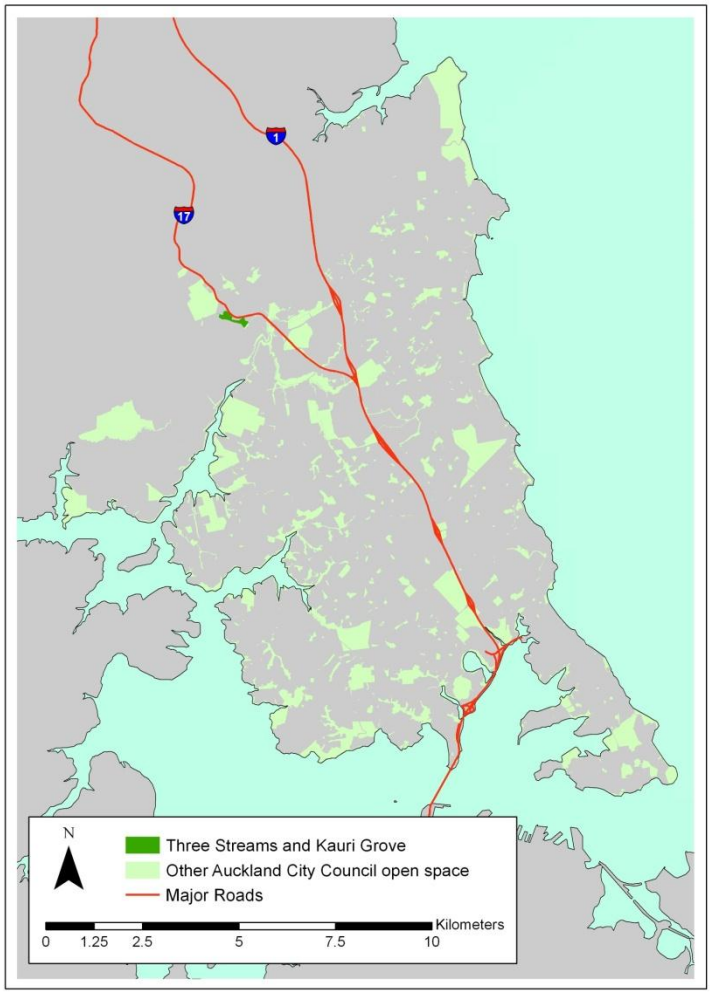
3. Background and Site Description

The Kauri Studies Trust was established in 2011 with an endowment of $50,000 from John Hogan, former owner of Three Streams. John Hogan is one of four trustees, the others being Ian Barton, Peter Maddison, and Dennis Viehland.

Though the TS and KG reserves share a boundary, their histories differ significantly. Kauri Grove is owned and managed by North Shore City Council (now Auckland City). Three Streams was privately owned, and managed privately or by various conservation trusts until 2005, when its ownership and management was transferred to the North Shore City Council. An excellent review of the history of management and legal status of Three Streams exists in the Reserve Management Plan (North Shore City Council 2006).

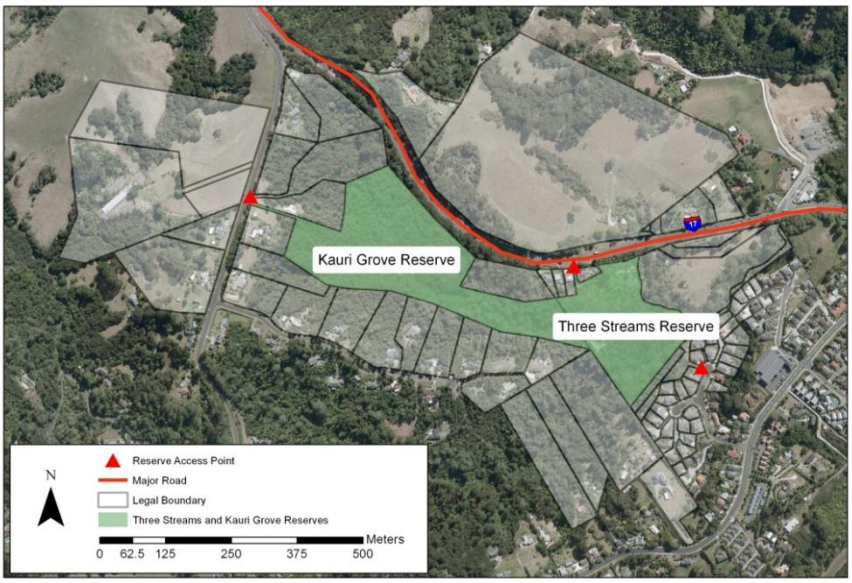
For context, Auckland City manages over 800 parks, reserves, domains, and other open spaces on the North Shore (Map 1).

The sites occupy 3.6 hectares (Three Streams) and 6.9 hectares (Kauri Grove). Together, they form a portion of a larger contiguous forested area in Albany on the North Shore (Map 2). Their broad surroundings are a mixture of land uses including low-density residential, rural, and commercial. Access to the reserves is via SH17, or public easements on Hobson Heights Road and Twin Court.



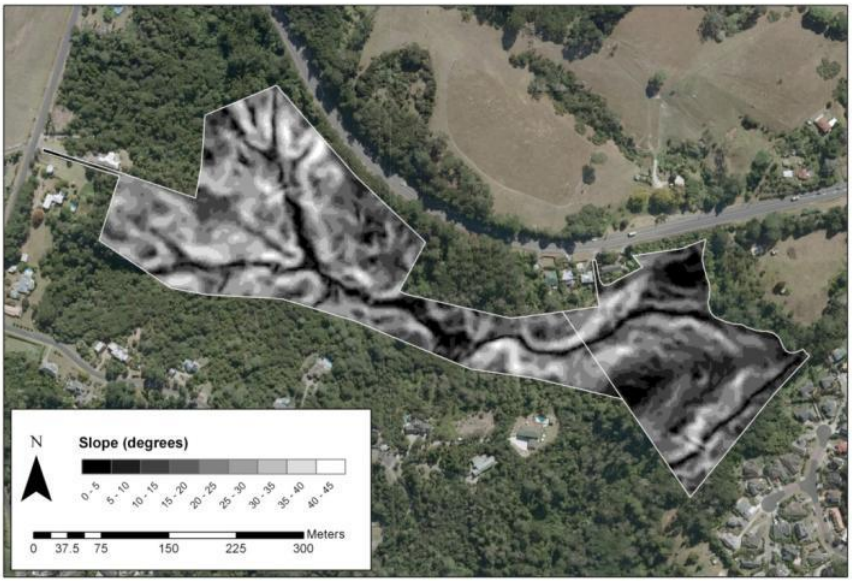
MAP 1 – THREE STREAMS AND KAURI GROVE RESERVES WITHIN THE CONTEXT OF SURROUNDING PARKS, RESERVES, DOMAINS AND OTHER OPEN SPACE MANAGED BY AUCKLAND CITY

* also known as Albany Heights West in the Gardner (2005) report, but will be known as Kauri Grove throughout this document



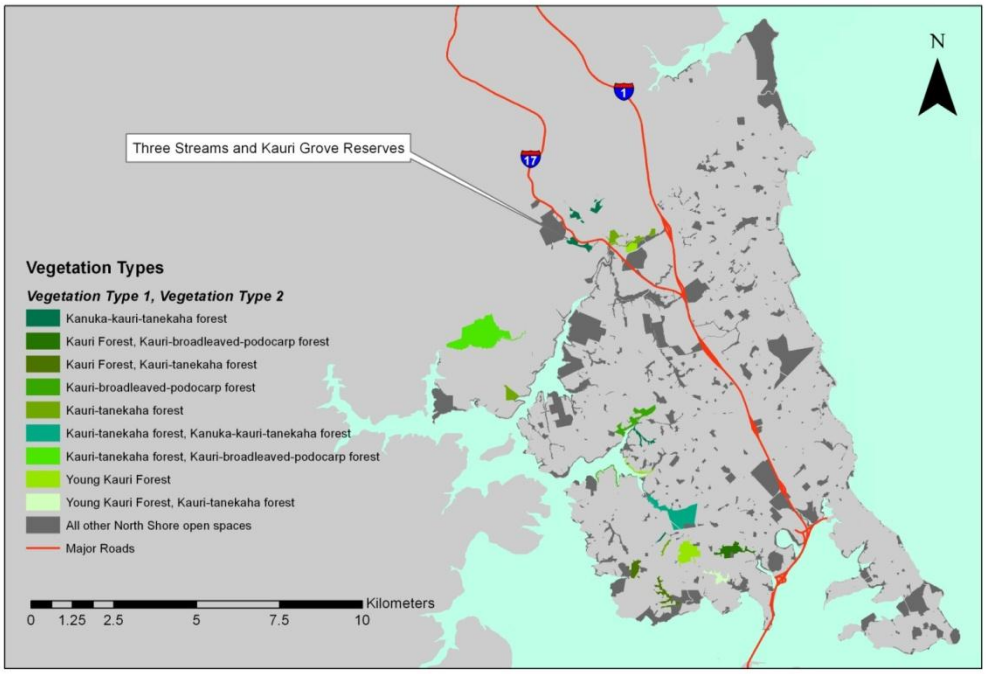
MAP 2 – THE LEGAL BOUNDARIES (WHITE SEMI-TRANSPARENT FILL WITH GREY BORDERS) FOR KAURI GROVE, THREE STREAMS, AND SURROUNDING LANDS

The landscape within the boundaries of TS and KG is steep and rugged (Map 3), with slope values exceeding 40 degrees in places. Narrow swaths of land bordering the rivers are generally flat, as are two small patches at the northern-most edge of TS and another on the south-west edge where TS borders KG. A combination of steep terrain, dense vegetation, and limited pedestrian access has ensured the reserves are relatively unaffected by the surrounding urbanisation and population. That being said, developments along Hobson Heights road (which share a border of Kauri Grove) are impacting the forest with signs of invasive weeds and septic tank drip tapes (See Appendix A, images 0622, 0623, and 0627). Both these problems were previously reported by Gardner (2005) .



MAP 3 – SLOPE VALUES FOR THREE STREAMS AND KAURI GROVE RESERVES

From an ecological perspective, Three Streams and Kauri Grove reserves are characterised (at a broad level) as kanuka-kauri-tanekaha forest (Myers 2005). This vegetation type, on the North Shore, is not endemic to TS and KG. In fact, nine other parks or reserves on the North Shore share this particular vegetation type (total of 33.3 ha). If we consider other parks and reserves on the North shore where kauri comprises a significant component of the vegetation type (ie. kauri-broadleaved-podocarp, kauri-tanekaha, or kauri forest), then TS and KG are but 2 of 43 parks and reserves (Map 4). The combined area of TS and KG is approximately 10.5 ha, only a fraction of the 360.8 ha of land on the North Shore where kauri is listed as a part of the vegetation type.



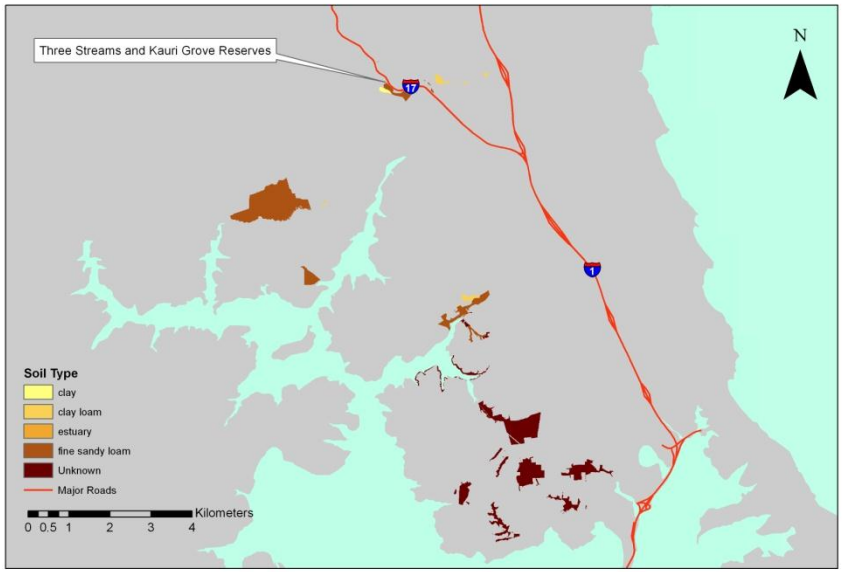
MAP 4 – NORTH SHORE PARKS INCLUDING KAURI AS A MAJOR COMPONENT OF THE VEGETATION.

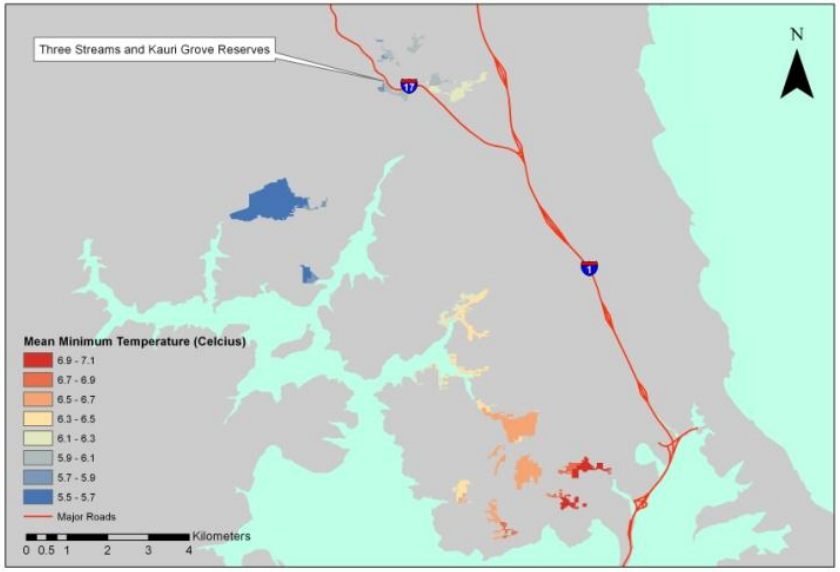
Vegetation surveys at different scales have been conducted. At the coarse scale, the TS and KG reserves are considered kanuka-kauri-tanekaha forest (Myers 2005), whereas at a finer scale, six vegetation sub-types are identified (Gardner 2005), including: maturing secondary forest of kauri and tanekaha; forest of taraire, puriri, some rimu and kahikatea; old tall scrub, mostly kanuka with young tanekaha, kauri; dense old pines, in places over tall kanuka and some tanekaha; damp scrub of broadleaved species and tree ferns; managed ground of mown grass and plantings (Map 5).

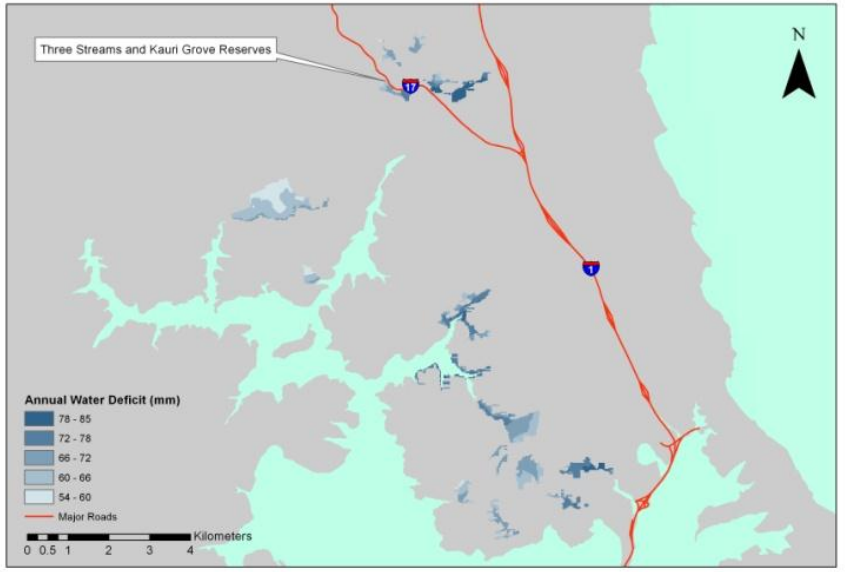
MAP 5 – VEGETATION SUBTYPES WITHIN THE THREE STREAMS AND KAURI GROVE RESERVES, IDENTIFIED BY RHYS GARDNER (2005).

Differences in vegetation types can be linked to variability of soil and climatic variables. For all land under the management of the former North Shore City Council, this variability can be significant. The kauri forests presented in map 4 span a range of soil types including clays, clay loams, and fine sandy loams (map 6a). Likewise, the temperature and annual water deficit differs markedly across kauri forests on the North Shore (map 6b and 6c). The soil and climatic parameters in map 6 represent only a small fraction of all data publicly available from Landcare Research (http://lris.scinfo.org.nz/). A full list of available soil and climatic data is presented in Appendix D.

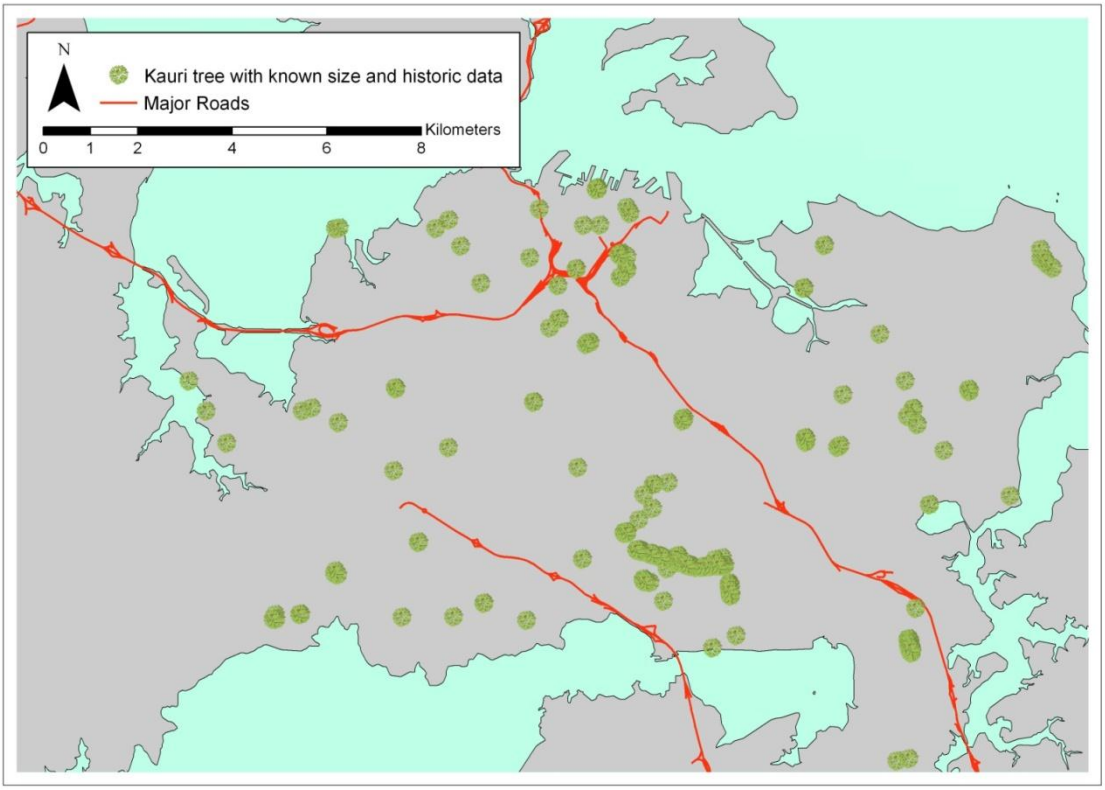
MAP 6 – VARYING SOIL TYPES (A – TOP RIGHT), MINIMUM TEMPERATURE (B – BELOW), AND ANNUAL WATER DEFICIT (C – BOTTOM RIGHT).







No comprehensive tree-level inventory has ever been conducted for the North Shore, so knowledge about individual kauri within the reserves is limited. That being said, the legacy North Shore City Council has a District Plan, which describes the location of 55 notable kauri trees (see Appendix B for a definition of notable tree). By definition, 'notable' kauri identified by the district plan will only be a fraction of the total number of kauri on the North Shore. Unfortunately, no descriptive data about the size or health of the 55 notable kauri are available. Furthermore, no spatially-referenced digital maps are available; the location of these notable trees can only be determined by finding the paper maps. There is the potential for these two shortcomings to be addressed by Auckland City. This is because the legacy Auckland City Council developed a geographic information system for their notable trees (Map 7). It is important to note that at present there is no indication from Auckland City that legacy council data will be digitised and amalgamated. But if such work were to be undertaken, the resulting geographic information system would allow the detailed spatial and attribute data of notable kauri to be visualised, analysed, and maintained as a historic record.



MAP 7 – LOCATION OF KAURI MANAGED BY AUCKLAND CITY. ALL TREES HAVE ASSOCIATED SIZE, HEALTH, AND PLANTING DATA.

4. Previous Works at Three Streams and Kauri Grove

One objective of this report is to facilitate future research. In order to fulfill this objective, it is important to understand the previous attempts to document the study sites. An understanding of previous works conducted at Three Streams and Kauri Grove Reserves allows us to identify gaps in the knowledge base such that future research can be prioritised. An excellent starting point for any future research is to explore the Three Streams website www.threestreams.org.nz, which is maintained by former Three Streams property owner John Hogan. The website provides information on the history of the Three Streams. In addition to this resource, a number of other formal and unpublished works describing Three Streams and Kauri Grove are available.

Formal studies at Three Streams and the surrounding areas have been conducted since 1999; they provide an account of vegetation and water resources, and some offer management recommendations. The six studies, summarised in Table 1, were conducted at different spatial scales, by different stakeholders, and therefore do not provide a cohesive ecological assessment. Furthermore, different methodologies preclude direct comparison between the works. Nevertheless, a compilation of the highlights of each of the works is presented here, in chronological order, for the benefit of the Trust and future researchers.

TABLE 1 - SUMMARY OF PREVIOUS WORKS AT THREE STREAMS AND KAURI GROVE RESERVES

Details	Highlights
Year: 1999 **Author**: Jonathan Hogan **Commissioned by**: NA **Title**: Ecological Restoration and Management of Three Streams Reserve in Albany **Scale:** Three Streams Reserve	• A report produced by Jonathan Hogan, son of John Hogan, provides indications of vegetation abundance and diversity within the Three Streams area • The unpublished report is only available as a paper copy from John Hogan's personal library and is missing appendix 9, which provides species codes ○ As is, the species codes (used in map legends) cannot be deciphered • Assuming that the species code 'Ka' represents kauri, it is possible to determine the abundance (by size class) in five 10 m^2 plots • Species 'Ka' was not found as naturally existing in any of the five plots (though it did exist as planted specimens) • The location of the five plots is not clear on the map provided (Appendix 2), precluding any future comparisons
Year: 2003 **Author**: Kaipatiki Ecological Restoration Project Inc., and Recreate **Commissioned by**: North Shore City Council and QEII Trust **Title**: Three Streams Arboretum and Kauri Grove Reserve - Ecological Restoration Plan **Scale:** Three Streams Reserve and Kauri Grove Reserve	• Incorrectly referred to as Walker, C. (2003) in numerous subsequent reports • Objective of providing a practical guide to restoration works required to reach the ecological objectives of the North Shore City Council and QEII Trust • Provides a management plan for Three Streams and Kauri Grove Reserves based on vegetation and stream surveys • Provides a list of species and their abundance for nine separate management areas, only within Three Streams Reserve ○ Quantification of vegetation abundance and spatial description of management areas did not follow any accepted scientific methods, precluding comparative studies

Details	Highlights

Year: 2005
 	
Author: Rhys Gardner
 	
Commissioned by: North Shore City Council
 	
Title: Kauri Grove Reserve and Three Streams Reserve: vegetations and flora, and management recommendations
 	
Scale: Three Streams Reserve and Kauri Grove Reserve
	• A comprehensive baseline vegetation survey
	• No methods or precise abundance estimates are provided, precluding comparative studies
	• Spatial data is only indicative, but helps identify boundaries for vegetation zones at a finer scale than the North Shore City Ecological Survey (Myers 2005)
	• The North Shore Ecological Survey identifies the entire Three Streams/Kauri Grove area as kanuka-kauri-tanekaha forest
	• This report has a finer scale and identifies 6 subcategories of vegetation:
	  ○ Maturing secondary forest of kauri, tanekaha
	  ○ Forest of taraire, puriri, some rimu and kahikatea
	  ○ Old tall scrub, mostly kanuka with young tanekaha, kauri
	  ○ Dense old pines, in places over tall kanuka and some tanekaha
	  ○ Damp scrub of broadleaved species and tree ferns
	  ○ Managed ground of mown grass and plantings

Year: 2005
 	
Author: Shona Myers
 	
Commissioned by: North Shore City Council and Auckland Regional Council
 	
Title: North Shore City Ecological Survey - A Survey of Sites of Ecological Significance in Tamaki and Rodney Ecological Districts
 	
Scale: North Shore
	• Lists “Sites of Ecological Significance” (SES) throughout the North Shore. SES with links to Three Streams Reserve and Kauri Grove Reserve include:
	  ○ Hobson Heights SES 011, Grid Reference R10 607 962
	  ▪ Comprises all of Kauri Grove
	  ○ Hobson Heights South SES 058, Grid Reference R10 607 959
	  ▪ Comprises all of Three Streams Reserve
	• The vegetation type associated with Three Streams and Kauri Grove is kanuka-kauri-tanekaha forest
	  ○ It is considered as successional forest

Details	Highlights

Year: 2006
 	
Author: NA
 	
Commissioned by: North Shore City Council
 	
Title: Kauri Grove, Three Streams and Serenity Reserves - Reserve Management Plan
 	
Scale: Three Streams Reserve, Kauri Grove Reserve, and Serenity Reserve
	• Provides a useful ownership and land use history of the sites
	  ○ Is an essential document for understanding the legal and planning context of the reserves and provides supporting maps
	• Management of the TS and KG reserves are governed by the 'Open Space Strategy 2000', the 'Strategic Plan 2001', the 'City Blueprint 2001', and the 'City Plan 2004'
	• All land, save the Three Streams reserve, is currently classified under the Reserves Act 1977, meaning the greatest level of ecological protection is afforded to the sites
	  ○ Council will classify the Three Streams as a scenic reserve under the Reserves Act 1977
	  ○ Department of Conservation and North Shore City Council Community Services and Parks Committee must approve the management plan
	• Such strict land use regulations may have an impact on the types of research that can be conducted
	• The Management Plan puts forward some objectives:
	  1. To complete legal classification of the reserves under the Reserves Act 1977 and to ensure appropriate District Plan zones are applied
	  2. To promote the integrated use and management of the reserves
	  3. To foster community involvement in the management of the reserves
	  4. To work effectively with Tangata Whenua in the management of the reserves
	  5. To provide the use of the reserves for educational purposes.
	  6. To provide safe and easy access to parts of the reserves, while protecting ecological and scenic values
	  7. To protect and enhance the ecological values of the reserves, control pests and weeds and manage any safety issues that might arise from branches dropping from large trees
	  8. To protect and interpret the heritage values of the reserve
	  9. To ensure that this management plan is monitored efficiently and implemented
	  10. To ensure that this document continues to reflect Council's goals for the development of the reserves
	• It is important to note that no mention is made of the use of the land for research purposes, but education is identified as an objective

Details	Highlights
Year: 2008 **Author**: Boffa Miskell Consultants **Commissioned by**: North Shore City Council **Title**: Three Streams, Kauri Grove & Serenity Reserve - Development Plan **Scale:** Three Streams Reserve, Kauri Grove Reserve, and Serenity Reserve	• This development plan follows on from the management plan for the same sites (North Shore City Council 2006) • A general report which uses maps to convey existing and potential pedestrian track locations within the reserves • A track system has been recommended which will bisect the Three Streams, Kauri Grove, and Serenity reserves, as well as link them to the Hosking and Obrien reserves, and Lucas Creek
Unpublished report by Waikato Institute of Technology	• Students from the Waikato Institute of Technology, under the supervision of Rob Graham, measured and tagged approximately 30 kauri trees. Unfortunately, the report was unavailable at the time of this reports writing. Nevertheless, the work presents an important record of the location and size of kauri trees planted at Three Streams reserve.

5. Suitability of the Site for Future Research

As a site for future research, Three Streams and Kauri Grove reserves offer numerous benefits, three of which are discussed here:

1) Proximity to major research institutions

2) Existing geospatial and reference data

3) Proximity to other reserves with similar vegetation cover

The proximity of TS and KG reserves to University of Auckland, Massey University (Albany), and the Waikato Institute of Technology ensures easy access for researchers and students. The research interests of some researchers at these institutions are very much in line with those of the Kauri Studies Trust (Table 2).

TABLE 2 – RESEARCH STAFF AT INSTITUTIONS IN CLOSE PROXIMITY TO THREE STREAMS AND KAURI GROVE RESERVES

Name	Institution	Contact	Research Interests
Cate Macinnis-Ng	School of Environment, University of Auckland	c.macinnis-ng@auckland.ac.nz	Her research interests are centered on understanding plant functional responses to environmental conditions. Currently working to quantify carbon cycling in kauri forests.
George Perry	School of Environment, University of Auckland	george.perry@auckland.ac.nz	His research interests lie broadly in the field of plant community and landscape ecology
Bruce Burns	School of Biological Sciences, University of Auckland	b.burns@auckland.ac.nz	His research interests cover the field of plant ecology in seeking to understand determinants and mechanisms of plant persistence, distribution and abundance. He identifies native forests and urban and rural forest ecosystems of being of particular interest.
Rob Graham	Arboriculture, Waikato Institute of Technology	m: 0274453171 w: 07 834 8800 x. 7916	His research interests lie in arboriculture, specializing in technical aspects of tree inspection, hazard tree analysis, and tree valuation

There is also potential to engage with researchers from other universities, further from Albany, but still within New Zealand. Some types of research require limited field work, so that proximity to the reserves is unnecessary. The University of Canterbury has the only School of Forestry in NZ and Australia and as such, has considerable expertise; Mark Bloomberg, David Norton, Euan Mason, and Justin Morgenroth are all researchers at the School of Forestry with primary or peripheral interests aligned with those of the Trusts. Similarly, Peter Lockhart at Massey University in Palmerston North and Len Gillman at Auckland University of Technology have some research interests in line with the interests of the Trust.

One strategy would be for the Trust to align itself with a university, rather than an individual researcher. One scenario is to make Three Streams and Kauri Grove reserves available as a dedicated field site for a university. As an example, the University of Canterbury owns, manages and maintains four field stations and countless field sites which are regularly used for study and

research purposes. It is possible that other universities have similar arrangements. There is potential to explore whether TS and KG would be suitable as a field station for kauri-related research.

A second major benefit of TS and KG as research sites is the existence of geospatial and ecological data for these sites. The studies listed in Table 1 provide a reference to the wealth of available ecological data. Additionally, former Three Streams Reserve proprietor John Hogan has records of planted kauri on the site, providing opportunity for comparisons of growth between planted and self-sown kauri. Geospatial reference data are managed by Auckland City and Landcare Research. These organisations can provide cadastral maps, data about soils, vegetation, landscape form, and climate. Contact gis@aucklandcouncil.govt.nz to determine their full complement of data. Similarly, see Appendix D to view data available from Landcare Research. The availability of such data makes possible broad-scale studies, and can be paired with local observations to produce results crucial to understanding environmental effects on kauri. For example, by combining local data on kauri growth, forest structure, or biodiversity with the available geospatial data, we can better understand the impacts of soil type, rainfall, nutrient availability, forest fragment area or shape, and proximity to urban centers. The research possibilities are limited only by imagination.

A third major benefit is the prevalence of other similarly vegetated sites on the North Shore. The vegetation cover at Three Streams and Kauri Grove reserves is characterised (at a broad level) as kanuka-kauri-tanekaha forest (Myers 2005). On the North Shore, this vegetation type is not unique to TS and KG, but is found in nine other parks or reserves. In total, there are 43 parks or reserves (360.8 ha) where kauri is included as a major component of the vegetation type (Map 4). This abundance of kauri forests on the North Shore provides an excellent opportunity to study kauri in a variety of urban and peri-urban locations, across environmental and even micro-climatic gradients.

The large number of potential study sites (of which TS and KG are a core component), proximity to research institutions, the availability of environmental and climatic geospatial data, and existing physical and human infrastructure combine to make TS and KG highly desirable study sites. To take advantage of these three major benefits, the following research directions are suggested:

1. Monitor kauri forest response to surrounding land use change.
2. Monitor kauri forest response to landscape form, soil physicochemical, and climatic factors.
3. Determine the effect of forest patch size and shape on kauri growth and health.
4. Explore native/exotic species interactions within kauri forests on the North Shore.
5. Explore the impacts of cultural practice on kauri seedling growth and survival.
6. Develop a kauri tree inventory.

6. Challenges to Research

Despite numerous benefits, challenges do exist with respect to the Kauri Studies Trust's support for research. The first challenge is twofold. How can the Trust best use the $50,000 endowment offered by John Hogan; then, what potential is there to increase the operating budget or use it to leverage other funding sources? With respect to the former question, there are two routes that the Trust may consider.

1. Invest a substantial portion of the endowment to establish the infrastructure necessary to support research.
2. Establish a periodic (annual, biennial) competitive grant, scholarship, or prize.

The first option is predicated on the belief that dispensing a large sum of the endowment initially will provide the catalyst for future funding and innovation. A series of permanent sample plots (PSP) are one means of establishing research infrastructure. As an example, the New Zealand National Forest Inventory uses plots measuring 20m by 20m to monitor carbon stocks. PSP are commonly used to monitor temporal changes in vegetation structure and diversity resulting from external factors like environmental and anthropogenic impacts associated with urbanisation. Establishing PSP over the whole range of kauri distribution (map 4), would provide insight into how kauri growth is affected by a number of environmental, climatic, and anthropogenic gradients. A twist on the PSP approach to establishing research infrastructure is to identify a series of individual trees (rather than plots), which can be measured at regular intervals. There is potential to include trees previously measured at Three Streams, but ideally the number and spatial distribution of trees would be expanded to include a broad range of environments. For effective future research use, baseline data from PSP or sample trees should be stored electronically, in a

geographic information system (GIS). A GIS will allow the data to be stored, updated, analysed, and visualised. The creation and upkeep of such a system must be factored into the costs of establishing a series of plots or sample trees. Alternatively, the Trust could seek to partner with an organisation like the NZNTT[1] (New Zealand Notable Trees Trust), which already maintains a tree register in the form of a GIS (http://register.notabletrees.org.nz/). Such a partnership may be mutually beneficial to both organisations.

The second option is more conservative and ensures that the Trust can support research in the long term. This report makes no attempt to provide a comprehensive economic analysis, but notes that Trusts generally only dispense a portion of the annual interest earned on the principal investment. In today's economy, with a 2.5% interest rate (matching record lows for NZ) the annual interest accrued on the principal is only $1,250.00. This sum, on its own, is unlikely to be sufficient to support a research programme (for perspective, the annual tuition for a post-graduate student ranges from $5,000-6,000). That being said, a portion of the annual interest could potentially be offered as a prize for undergraduate honours projects. This would require the trust to align itself with a school of program within a university. With respect to the latter part of the first challenge, the Trust may seek to leverage their endowment, by applying for funding for competitive grants or funds matching programs.

The second challenge has the potential to threaten research efforts based at TS and KG reserves. This is because the reserves are legal entities owned and managed by Auckland City. Three Streams reserve is also governed by the Open Space Covenant pursuant to the Queen Elizabeth II (QEII) National Trust Act 1977. This does not preclude research at the reserves, but it is likely to limit the types of research that can be conducted on site.

Without knowing Auckland City and the QEII National Trust's position on research within the reserves, it is difficult so proceed. Contingent on the council's stance, one of three outcomes are possible.

1. All research within the reserves is prohibited. This outcome is highly limiting, but some types of research are still possible. This would likely be limited to economic or geospatial studies where data already exists and does not have to be collected from within the reserves.
2. Non-invasive research within the reserves is deemed acceptable. This outcome will allow for surveying and non-destructive sampling. It is possible that with this outcome, the council would consider the installation of physical markers for permanent sample plots or identification of sample trees. Alternatively, PSP could be established with GPS (global positioning system), though positional accuracy is limited, especially beneath forest canopy.
3. All research will be considered, but Auckland City and the QEII Trust must be consulted. This outcome is least limiting to research and there is even potential for destructive sampling. This would allow for studies involving coring, limbing, or even felling. These are typical methods for determining the age and growth rate of trees. Even studies of carbon storage and sequestration often require wood samples to be collected (and this may be considered destructive).

Clearly, a positive relationship with Auckland City and the QEII National Trust must be built if TS and KG are to feature as sites for future research supported by the Kauri Studies Trust. The Trust may simply have to support observational, rather than experimental or sampling-based approaches to research. This is not necessarily a negative result as the abundance of open space on the North Shore containing kauri as a major component of vegetation type lends itself to survey-based research.

7. RECOMMENDATIONS

The Kauri Studies Trust wishes to support kauri-related research, with a focus on kauri in urban and peri-urban areas. In order to achieve this, the following actions are recommended.

As a first step, the Trust should seek to determine what steps are necessary to conduct research at the Three Streams and Kauri Grove reserves. By seeking this crucial information from Auckland City and The QEII National Trust, the Kauri Studies Trust will be in a better position to understand the types of research that it can support. As a first point of contact at Auckland City, it is recommended that the Trust contact Tony Hart (tony.hart@aucklandcouncil.govt.nz) and Paul Duffy (paul.w.duffy@aucklandcouncil.govt.nz). Tony's role is as Parks Advisor for the Upper Harbour Local Board Area, while Paul is the Volunteer and Biodiversity Coordinator for Local and Sports Parks North. Both were recommended by Nicki Malone. If these Auckland City staff are unsuitable, the Trust should contact Mark Bowater (mark.bowater@aucklandcouncil.govt.nz). In his role as manager for local and sports parks, he will be in a position to provide advice or make the necessary decisions. The QEII National Trust has a national office in Wellington and can be contacted on (04) 472 6626.

1 – The author of this report is a trustee on the NZNTT

A second crucial undertaking is to establish research themes or goals. These are necessary to ensure that the Trust has a common direction. For an organisation with the goal of supporting research, an outline for research goals are synonymous with a mission statement. From a broad perspective, the Trust has indicated that they wish to support research of kauri growing in urban and peri-urban areas. It is recommended that the Trust identify specific goals or themes within the confines of this broad goal in order to help determine the suitability of future requests for funding. The list of research directions provided in section 5 above provides a starting point and attempts to take advantage of the strengths of TS and KG as a research site.

A third role for the Trust will be to ensure that any future research initiatives have access to reliable baseline data. The scope for this task is broad. The Trust could simply provide prospective researchers with access to existing data. This report provides a comprehensive summary of previous research at TS and KG, as well as indications of data availability and sources. At the other extreme, the Trust could take a more active role in providing new baseline data. This can be achieved by establishing permanent sample plots or sample trees, with the goal of future surveys leading to a better understanding of kauri growth and ecology within dynamic populated environments. Naturally, this could only be achieved with cooperation from Auckland City and the QEII National Trust. Sites with established PSP would prove very attractive to prospective researchers as the infrastructure for long-term research is in place.

A final task for the Trust is to seek out relationships with researchers. The Kauri Studies Trust is well positioned to approach researchers and request proposals meeting the research goals. Annual competitive grants can help ensure continued interest from the research community.

Attention to these four recommendations will help ensure that the Kauri Studies Trust attains its goal of supporting research for remnant kauri in urban and peri-urban areas.

8. REFERENCES

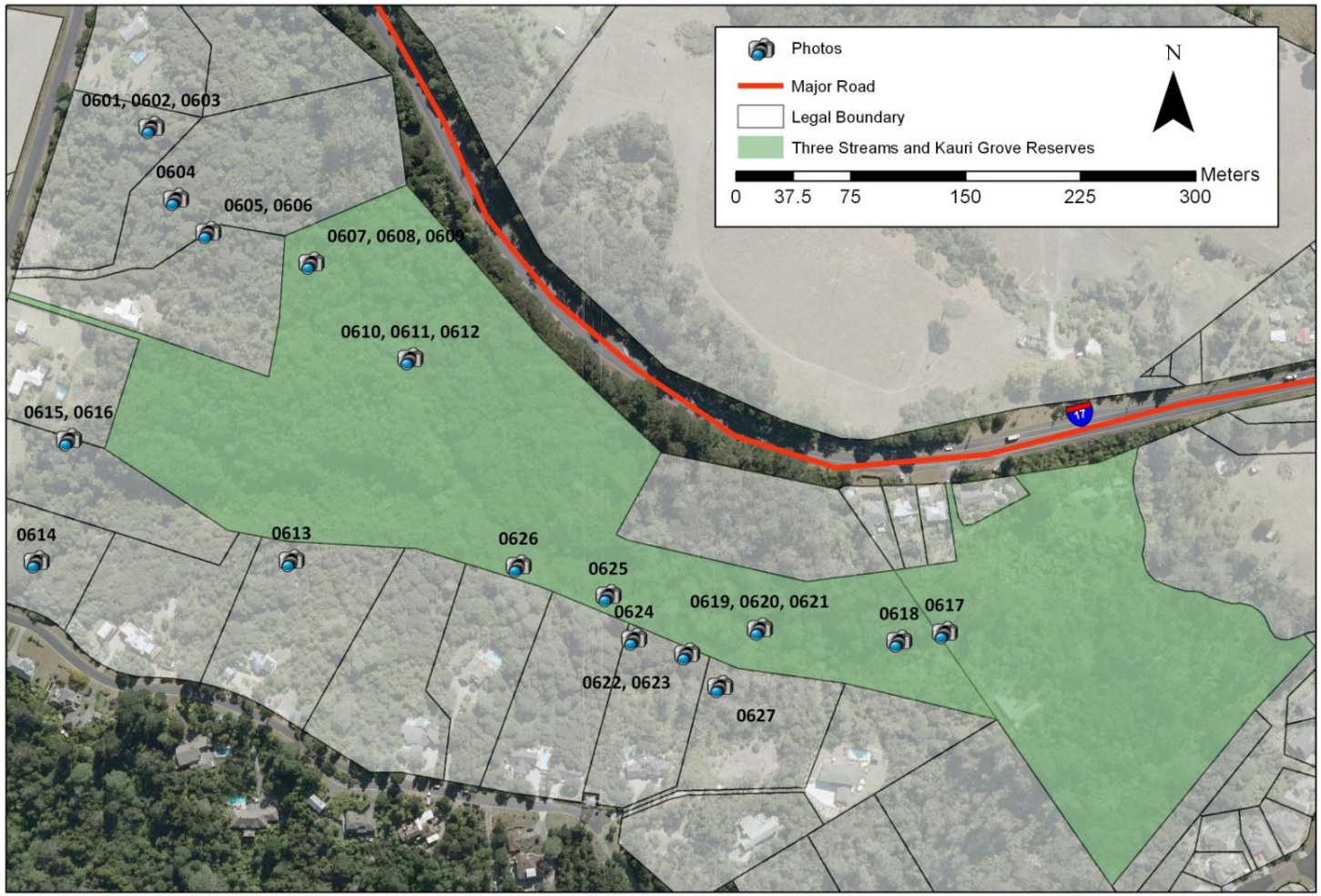
Gardner, R. 2005. Albany Heights West Reserve and Three Streams Reserve: vegetations and flora, and management recommendations. Prepared for Parks Department, North Shore City Council.

Myers, S. 2005. North Shore City Ecological Survey - A Survey of Sites of Ecological Significance in Tamaki and Rodney Ecological Districts. Auckland Regional Council.

North Shore City Council. 2006. Kauri Grove, Three Streams and Serenity Reserves - Reserve Management Plan.

APPENDIX A – PHOTOS FROM THREE STREAMS AND KAURI GROVE

Image caption numbers in the table below correspond to the locations denoted on the map here:



APPENDIX A – CONTINUED…

Image	Caption
	**Image 0601**. Natural kauri regeneration. Seedling measures approximately 40 cm in height.
	**Image 0602**. Saplings recruiting into the canopy gaps.
	**Image 0603**. The steep landscape at the western edge of Kauri Grove.

APPENDIX A – CONTINUED…

Image	Caption
	**Image 0604**. Kauri measuring 66.4 cm diameter at breast height. Note: small pack included in image to provide scale.
	**Image 0605**. Pocket of kauri regeneration. Numerous seedlings and saplings measuring 50 cm – 6 m in height.
	**Image 0606**. View of dense forest at western edge of Kauri Grove.

APPENDIX A – CONTINUED…

Image	Caption
	**Image 0607**. Kauri measuring 100.9 cm diameter at breast height.
	**Image 0608**. View of the base of 101cm kauri shown in image 0607. Note: small pack included in image to provide scale.
	**Image 0609**. Colours revealed by bark which has sloughed off.

APPENDIX A – CONTINUED…

Image	Caption
	**Image 0610**. View of the valley bottom, vegetation is composed of tree ferns, palms, and broadleaf trees.
	**Image 0611**. View of the valley bottom, vegetation is composed of tree ferns, palms, and broadleaf trees.
	**Image 0612**. Tui perched on a branch in a tree on the valley floor.

APPENDIX A – CONTINUED…

Image	Caption
	**Image 0613**. Kauri measuring 60.6 cm diameter at breast height.
	**Image 0614**. Split-leader kauri measuring 62.6 cm diameter at breast height.
	**Image 0615**. Kauri measuring 59.1 cm diameter at breast height.

APPENDIX A – CONTINUED…

Image	Caption
	**Image 0617**. Path in average condition. Vegetation is encroaching, rendering path very narrow at points.
	**Image 0618**. Bridge in a state of disrepair.
	**Image 0619**. Small waterfall at eastern edge of Kauri Grove.

APPENDIX A – CONTINUED…

Image	Caption
	**Image 0620**. The result of walking too close to the stream edge.
	**Image 0621**. Very dense understory at the eastern edge of Kauri Grove.
	**Image 0622**. Septic tank drip tapes on the slopes of the south-eastern boundary of Kauri Grove. Properties on Hobson Heights road share this boundary.

APPENDIX A – CONTINUED…

Image	Caption
	**Image 0623**. Septic tank drip tapes on the slopes of the south-eastern boundary of Kauri Grove. Properties on Hobson Heights road share this boundary.
	**Image 0624**. A kanuka grove along the south-east border of Kauri Grove.
	**Image 0625**. Kauri regeneration in both the foreground and background of the photo.

APPENDIX A – CONTINUED…

Image	Caption
	**Image 0626**. Heavy build-up of pine needle litter on southern edge of Kauri Grove. The understory is relatively sparse.
	**Image 0627**. Septic tank drip tapes on the slopes of the south-eastern boundary of Kauri Grove. Properties on Hobson Heights road share this boundary.

APPENDIX B – NORTH SHORE CITY COUNCIL DEFINITION OF NOTABLE TREES

The following text is copied verbatim from Appendix 8C of the North Shore District Plan.

Criteria for Assessing Notable Trees

Four categories of Notable Trees have been identified as particularly worthy of recognition and protection.

A. **A Most Significant Trees**
   - Any tree particularly outstanding for its species in relation to its age, size and form
   - Any tree that has significant landmark value due to its location
   - Any tree or trees which have outstanding value because of the amenity they provide or for their ecological, scientific or other significance.

B. **Historic Trees**
   - Any tree associated with or commemorating an historic event
   - Any tree associated with or planted by an historic or notable figure
   - Any tree of spiritual or cultural value.

C. **Rare or Unusual Trees**
   - Any significant tree of species rare in the region
   - Any significant tree of unusual genetic or morphological form.

D. **Trees of Local Significance**

E. In determining whether trees are worthy of protection, the following factors are considered:

   Size - the height and canopy spread of the tree.

   Visibility - amenity value and accessibility to the public.

   Presence of Other Trees - whether solitary or in a group or bush setting.

   Occurrence of the Species - how common or rare.

   Role in Location - visual and spatial quality surrounding the tree.

   Useful Life Expectancy - based on expected life-span and any actual or potential threats or compromises to the tree's environment.

   Form and Condition - whether the tree is well-shaped with a balanced branch system, and how well the trunk contributes to its visual appearance. Tree health is also taken into consideration in this category.

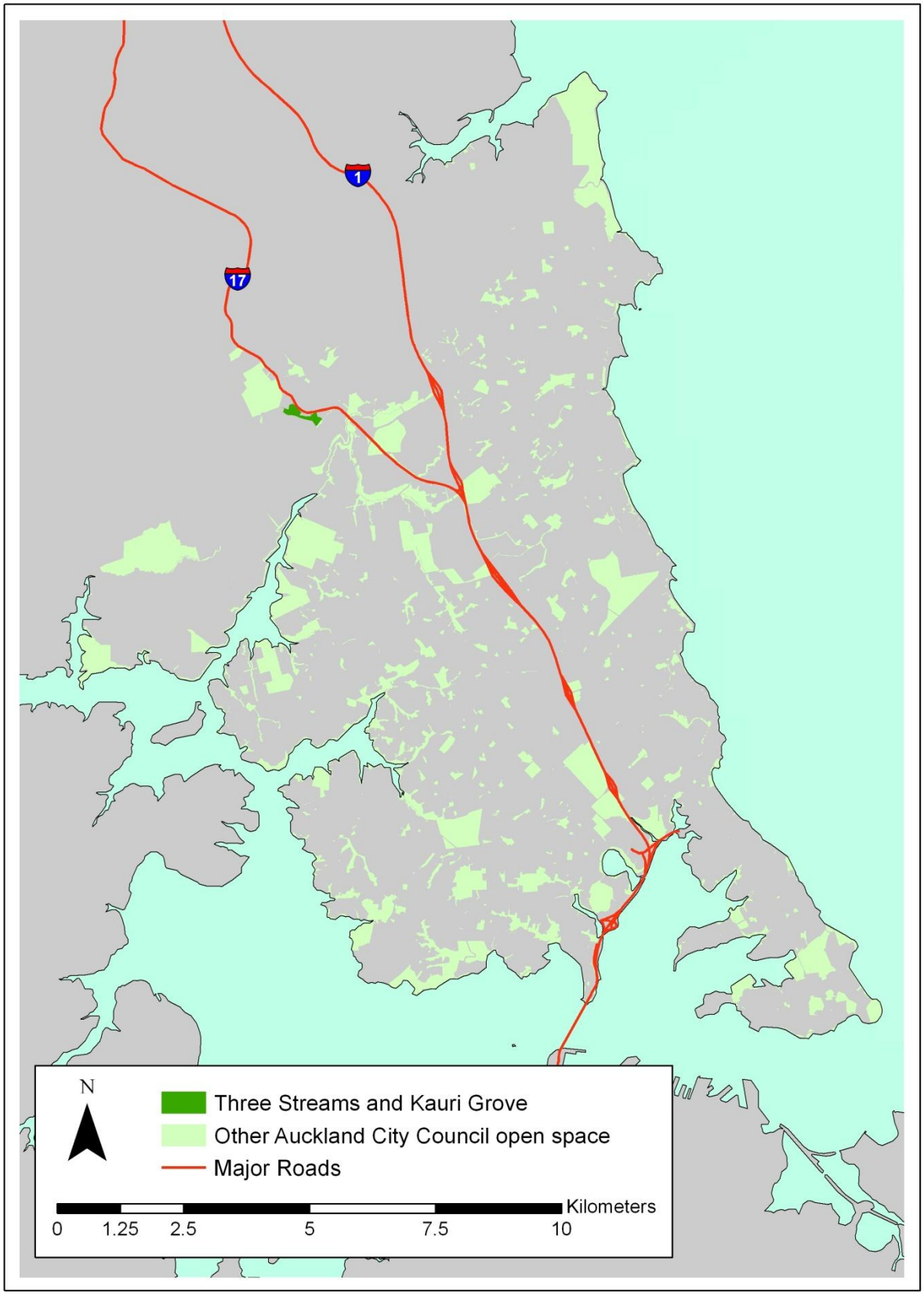
   Special Factors - historic association, ecological or scientific significance, social or cultural significance, or other special factor is considered.

   Indigenous Status - geographic significance. Whether the tree is exotic or, if native, how restricted its natural range.

Those trees included in the schedule are considered to be community assets which would be valued ahead of most land development proposals which might endanger them or compromise their form or condition.

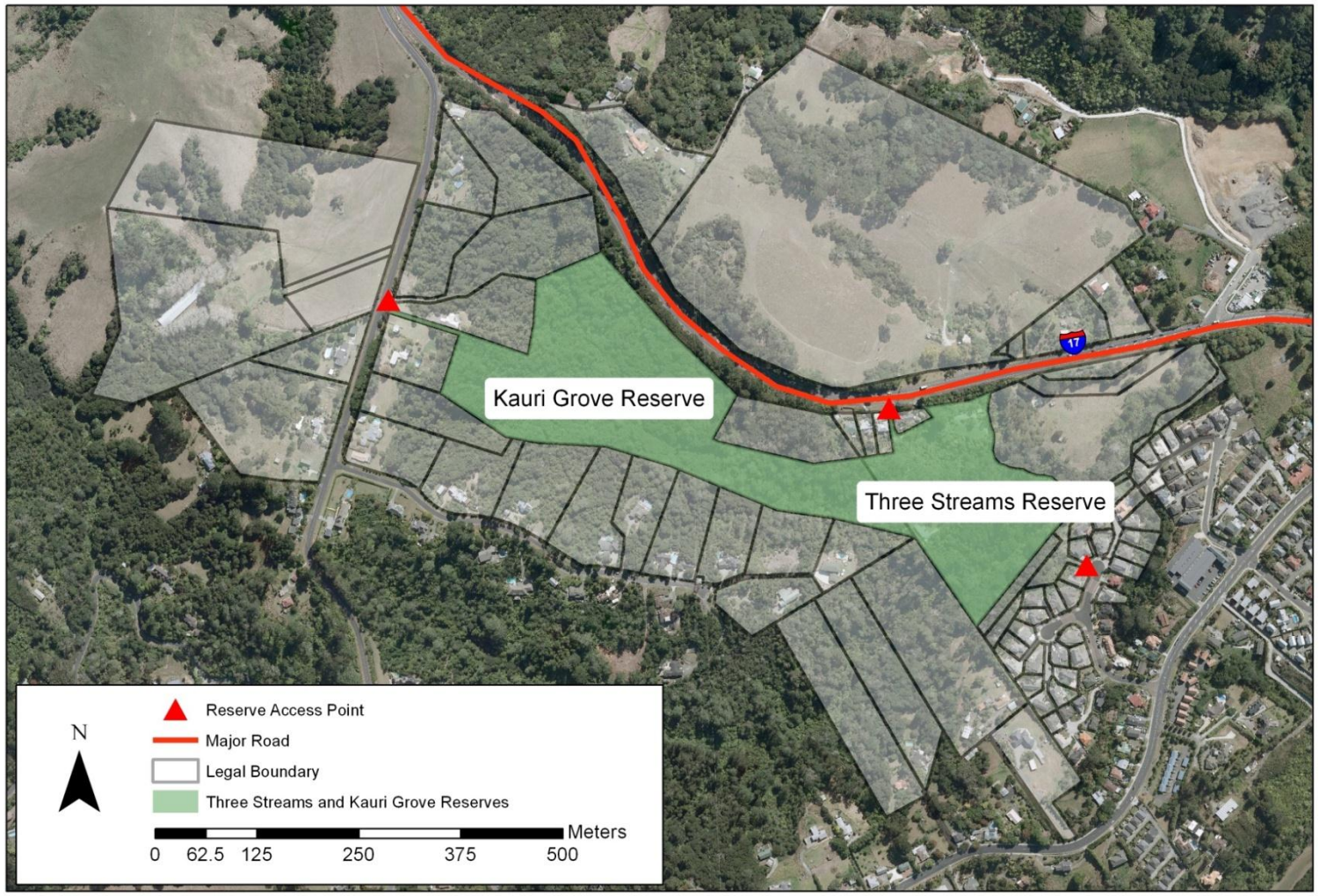
APPENDIX C – FULL PAGE (A4) MAPS AND DESCRIPTION OF DATA SOURCES

MAP 1– THREE STREAMS AND KAURI GROVE RESERVES WITHIN THE CONTEXT OF SURROUNDING PARKS, RESERVES, DOMAINS AND OTHER OPEN SPACE MANAGED BY AUCKLAND CITY. NORTH SHORE OPEN SPACE DATA PROVIDED BY NORTH SHORE CITY COUNCIL AND AVAILABLE FROM http://koordinates.com/#/layer/1440-north-shore-city-parks/

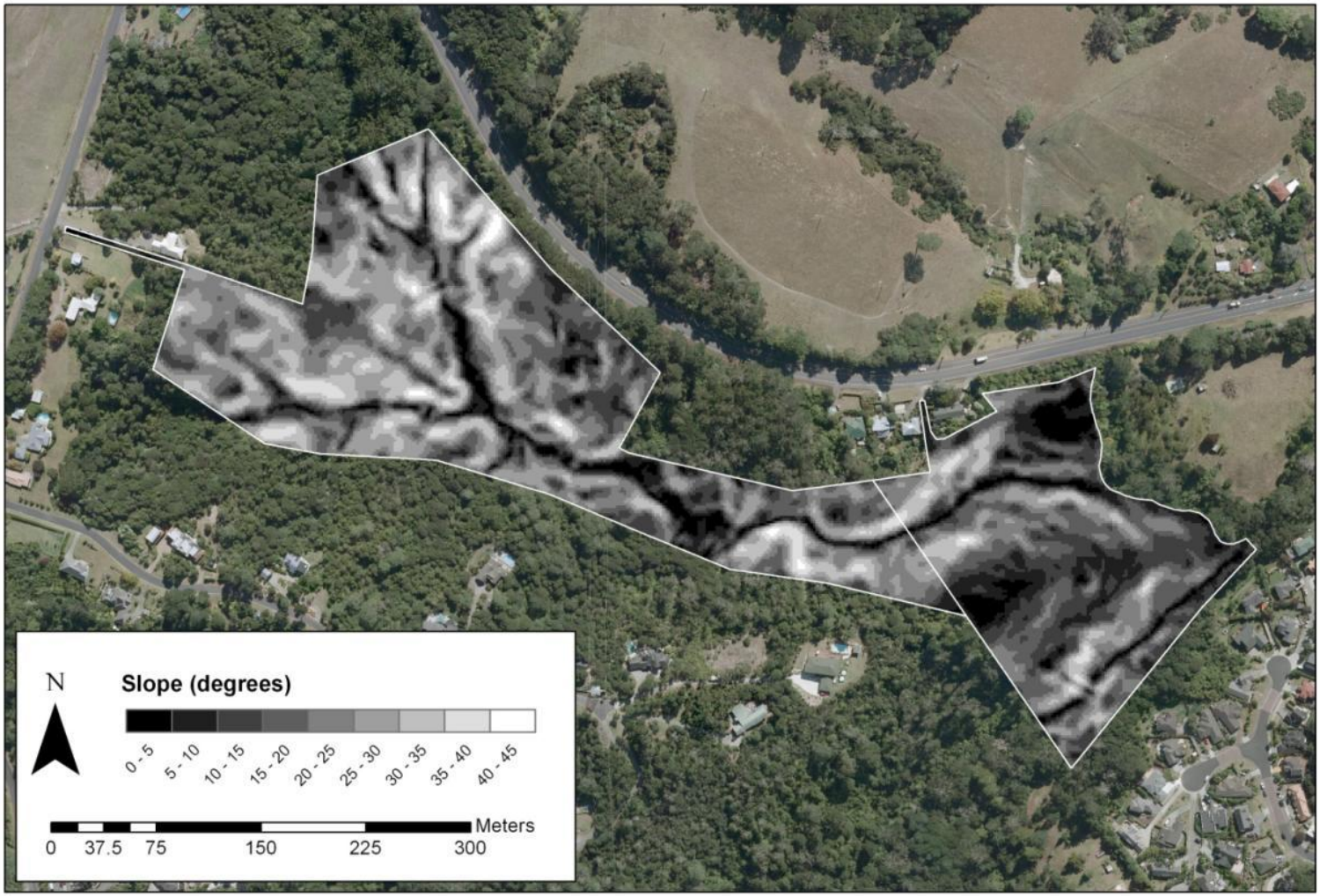


APPENDIX C – FULL PAGE (A4) COPIES OF MAPS INCLUDED IN THE REPORT…CONTINUED

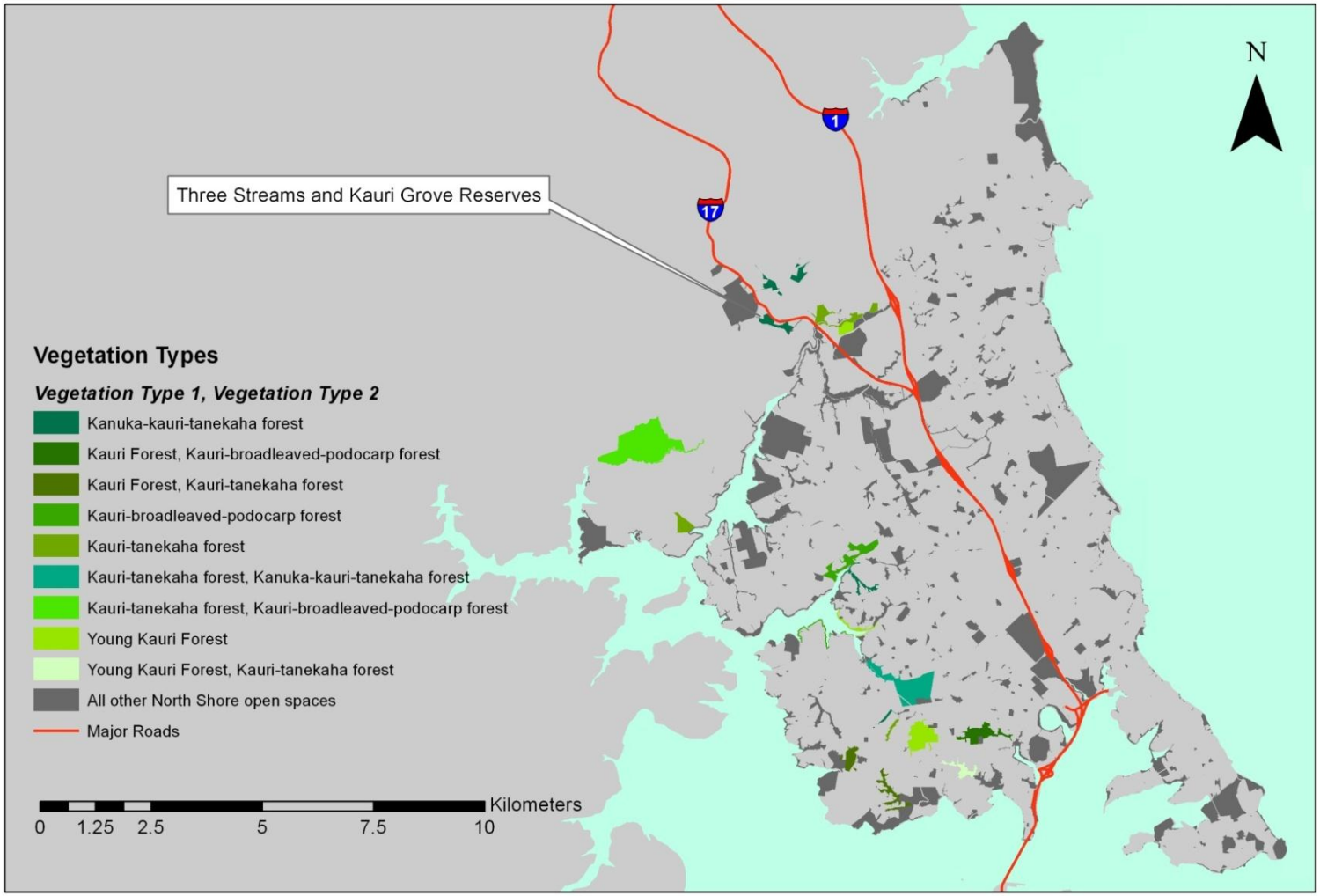
MAP 2– THE LEGAL BOUNDARIES (WHITE SEMI-TRANSPARENT FILL WITH GREY BORDERS) FOR KAURI GROVE, THREE STREAMS, AND SURROUNDING LANDS. LEGAL BOUNDARIES PROVIDED BY AUCKLAND CITY AND AVAILABLE FROM http://maps.aucklandcouncil.govt.nz/aucklandcouncilviewer/. RESERVE ACCESS POINTS WERE DETERMINED BY GPS AND ARE INCLUDED AS DIGITAL FILES AS PART OF THIS REPORT.



MAP 3– SLOPE VALUES FOR THREE STREAMS AND KAURI GROVE RESERVES. SLOPE DATA DERIVED FROM CONTOUR DATA (0.25M) PROVIDED BY AUCKLAND CITY, WHICH IS AVAILABLE FROM http://maps.aucklandcouncil.govt.nz/aucklandcouncilviewer/. DERIVED SLOPE FILES ARE INCLUDED AS DIGITAL FILES AS PART OF THIS REPORT.

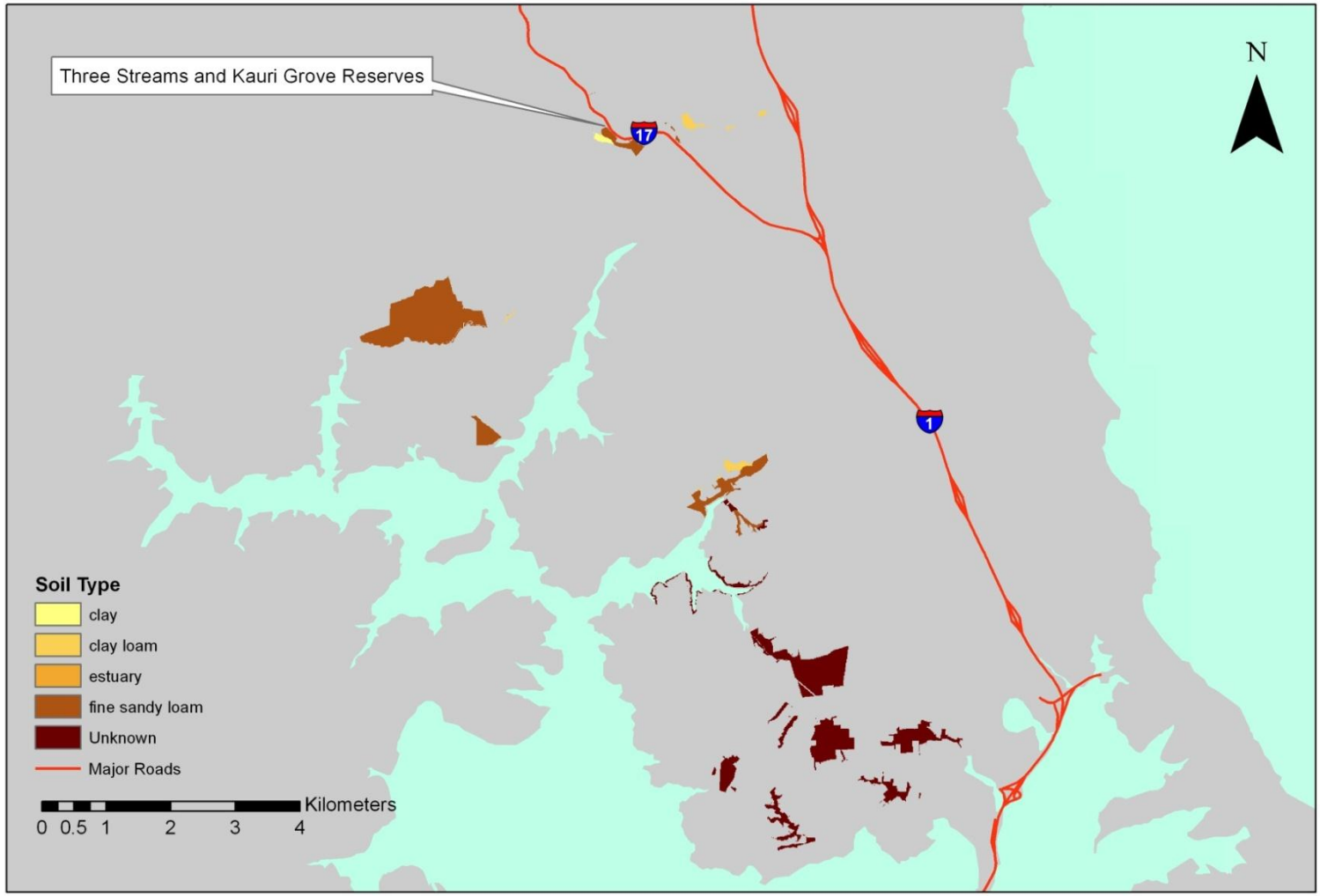


MAP 4 – NORTH SHORE PARKS INCLUDING KAURI AS A MAJOR COMPONENT OF THE VEGETATION. NORTH SHORE OPEN SPACE DATA PROVIDED BY NORTH SHORE CITY COUNCIL AND AVAILABLE FROM http://koordinates.com/#/layer/1440-north-shore-city-parks/. Vegetation types were assigned based on determinations made by the North Shore City Ecological Survey (Myers 2005).

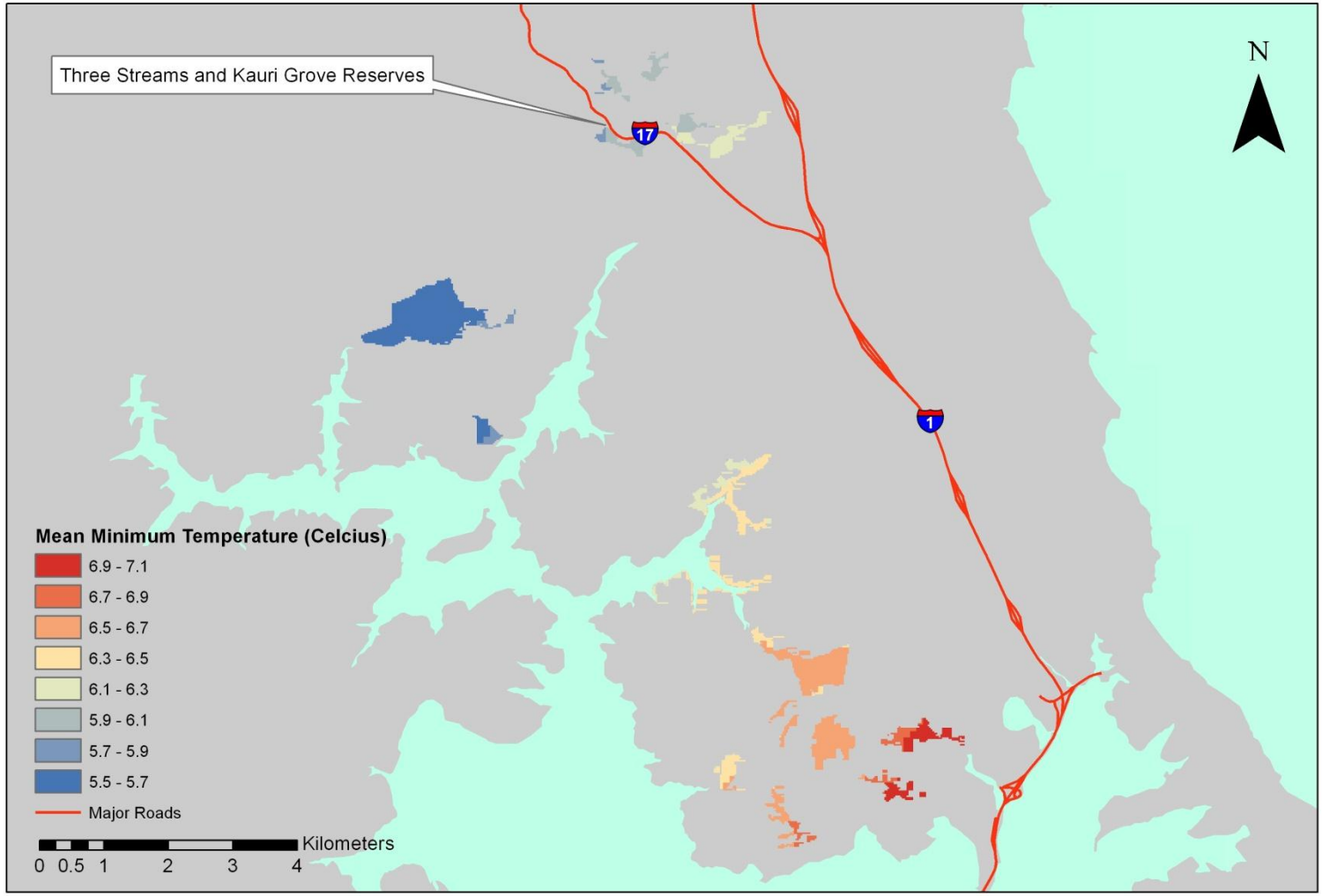


MAP 5 – VEGETATION SUBTYPES WITHIN THE THREE STREAMS AND KAURI GROVE RESERVES, IDENTIFIED BY RHYS GARDNER (2005).

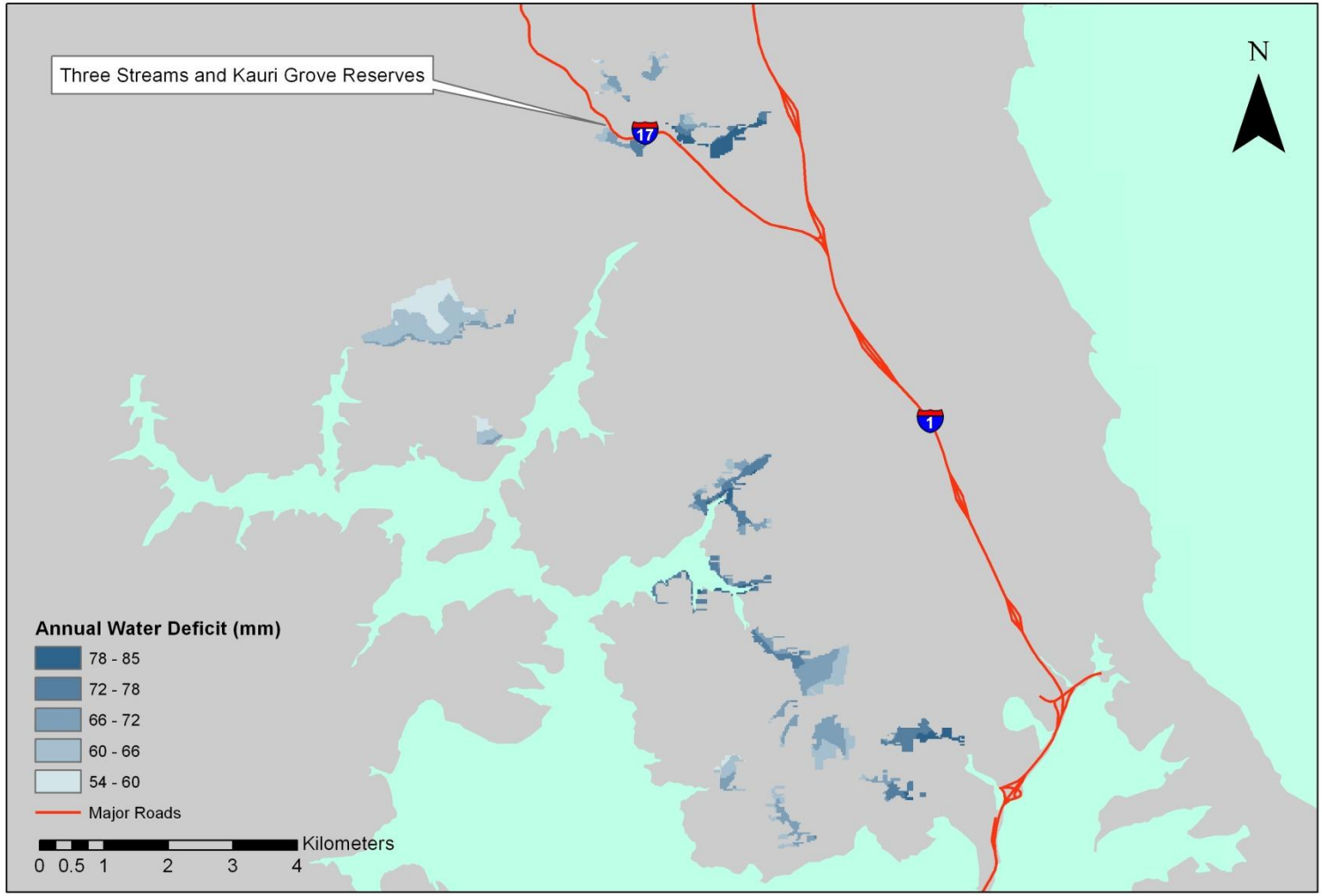
MAP 6A – SOIL TYPES WITHIN KAURI FORESTS ON THE NORTH SHORE. FUNDAMENTAL SOIL LAYER DATA PROVIDED BY LANDCARE RESEARCH AND AVAILABLE AT: http://lris.scinfo.org.nz/



MAP 6B – MEAN MINIMUM TEMPERATURE OF THE COLDEST MONTH FOR KAURI FORESTS ON THE NORTH SHORE. DATA PROVIDED BY LANDCARE RESEARCH AND AVAILABLE AT: http://lris.scinfo.org.nz/

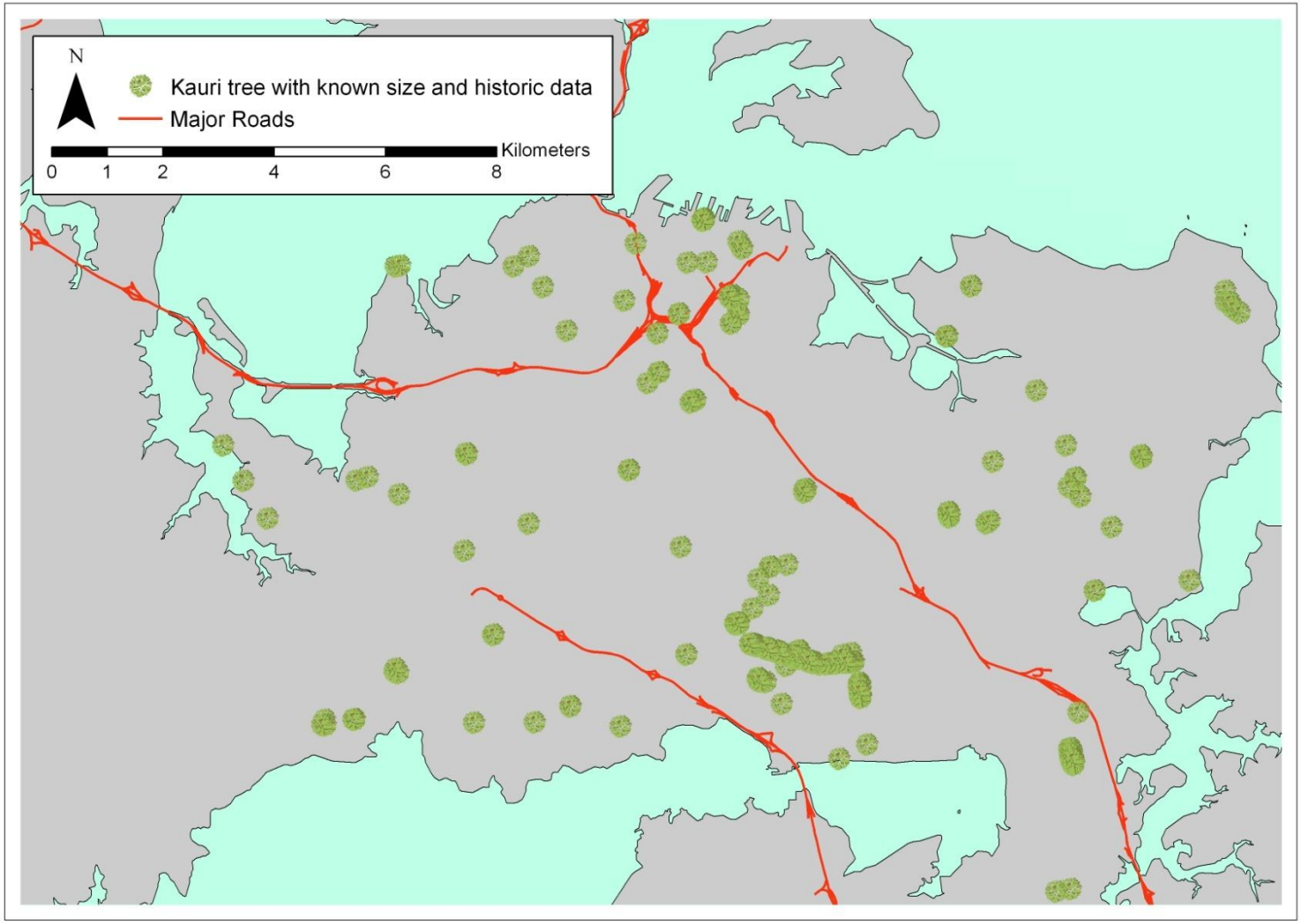


MAP 6C – ANNUAL WATER DEFICIT WITHIN KAURI FORESTS ON THE NORTH SHORE. DATA PROVIDED BY LANDCARE RESEARCH AND AVAILABLE AT: http://lris.scinfo.org.nz/



APPENDIX C – FULL PAGE (A4) COPIES OF MAPS INCLUDED IN THE REPORT…CONTINUED

MAP 7 – LOCATION OF KAURI MANAGED BY AUCKLAND CITY. ALL TREES HAVE ASSOCIATED SIZE, HEALTH, AND PLANTING DATA. DATA HAS BEEN PROVIDED BY AUCKLAND CITY. CONTACT gis@aucklandcouncil.govt.nz TO REQUEST THE DATA.



APPENDIX D – EXISTING SOIL AND CLIMATIC DATA

All these data are freely available from the LRIS portal maintained by Landcare Research (http://lris.scinfo.org.nz/).

Parameter	Description
Lithology	physiographic areas of relatively homogenous surface and near-surface rock type
Slope class	physiographic areas of relatively homogeneous average slope class
Erosion form and degree	physiographic areas with an inventory of up to four significant erosion forms and their severities
Productivity indices	land areas classified according to their stock carrying capacity (ewe equivalents, at three intensities of stocking), and site index for *Pinus radiata* (expressed as a range, an average, and a class)
pH	soil pH
Salinity	percent soluble salts (g/100g soil)
Cation exchange capacity	weighted averages for the soil profile from 0–0.6 m depth and expressed in units of centimoles of charge per kg (cmoles (+)/kg)
Total carbon	Total carbon (organic matter content) is estimated as weighted averages for the upper part of the soil profile from 0–0.2 m depth, and expressed as a percentage
Phosphate retention	estimated as weighted averages for the upper part of the soil profile from 0–0.2 m depth, and expressed as a percentage
Topsoil gravel content	Gravel classes ranging from non-gravelly to extremely gravelly
Rock outcrops and surface boulders	the percentage of the area of the map units covered by rock outcrops or surface boulders
Particle size class	a description of the soil particle size
Potential rooting depth	the minimum and maximum depths (in metres) to a layer that may impede root extension
Depth to slowly permeable horizon	describes the minimum and maximum depths (in metres) to a horizon in which the permeability is less than 4mm/hr
Soil drainage class	are assessed using criteria of soil depth and duration of water tables inferred from soil colours and mottles, or from reference to diagnostic horizons
Permeability profile	the rate that water moves through saturated soil. The permeability of a soil profile is related to potential rooting depth, depth to a slowly permeable horizon and internal soil drainage
Flood interval return	Flood interval return classes in years

Soil temperature regime	classes relate to the soil temperature at 0.3 m depth
Profile total available water	profile total available water for the soil profile to a depth of 0.9 m, or to the potential rooting depth (whichever is the lesser)
Profile readily available water	profile readily available water for the soil profile to a depth of 0.9 m, or to the potential rooting depth (whichever is the lesser)
Macroporosity	an expression of the air-filled porosity of the soil at 'field capacity'. Values are minimum values over the specified profile section (0–0.6 m and 0.6-0.9 m), and are expressed as a percentage of the soil volume
Mean annual temperature	the mean of the 12 monthly averages for daily average temperature
Mean minimum temperature of the coldest month	the mean minimum temperature in July, the coldest month of winter. Derived from monthly estimates of mean daily temperatures
Mean annual solar radiation	hours of solar radiation
Winter solar radiation	winter solar radiation reaches a minimum in June, the month when the sun is lowest in the sky and day lengths are at their shortest
October vapour pressure deficit	vapour pressure deficits in October were used in LENZ as this is the month when westerly winds are generally most persistent, resulting in strong geographic variation in vapour pressure deficits across New Zealand
Annual water deficit and monthly water balance ratio	derived from surfaces fitted to monthly data describing daily average temperature, daily solar radiation and monthly rainfall